# ATLAS, part 1

**Brief status of global LHC & ATLAS**

**The LBNL ATLAS group**

**Hardware activities:**

- **The ATLAS pixel detector**
- **Pixel hardware at LBNL**
- **Pixel hardware at CERN**
- **SCT hardware at CERN**

**Upgrade activities**

# LHC status

(Talk by Lyn Evans at Oct LHCC Meeting)

- Main objectives:
  - terminate installation in February 2007
  - first collisions in summer 2007
- The industrial production of standard components is compatible with this objective.
- The ramping up of QRL activities and magnet installation is critical to maintain this schedule.
- Additional actions have been implemented to ensure proper QRL production and installation rates.
- The installation and interconnection of cryomagnets have started in the tunnel.
- The commissioning of technical systems will take place in two adjacent sectors in parallel.
- Main next actions:
  - partial test of sector 7-8 in autumn 2005 (done).
  - Fast installation of 7-8 followed by 8-1 for a beam test in Autumn 2006.

QRL: Cryogenic distribution lines. Had problems in 2004 and many had to be reworked. Schedule has mostly recovered from this.

# LHC Taking Shape

LHC Progress Dashboard

Accelerator Technology Department

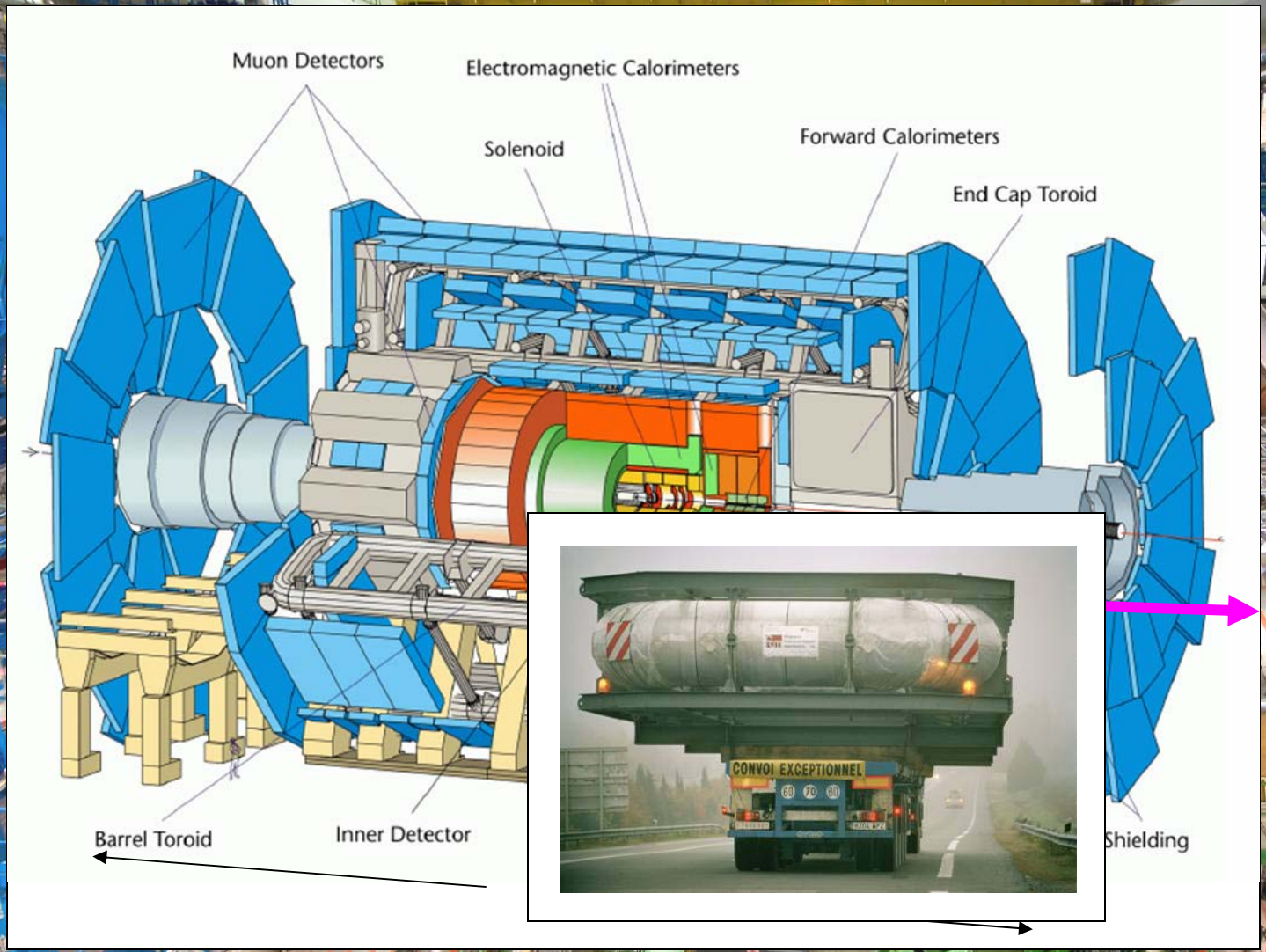
Cryodipole overview




Updated 31 Oct 2005

Data provided by D. Tommasini AT-MAS, L. Bottura AT-MTM

# ATLAS

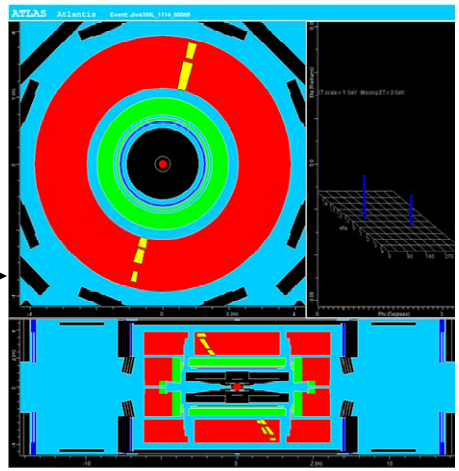

Muon Detectors
Electromagnetic Calorimeters
Solenoid
Forward Calorimeters
End Cap Toroid
Barrel Toroid
Inner Detector
Shielding
CONVOI EXCEPTIONNEL

# Barrel toroids are not alone

**Already in the cavern**

Barrel Calorimeters
(EM + HAD) ready to move to Z=0

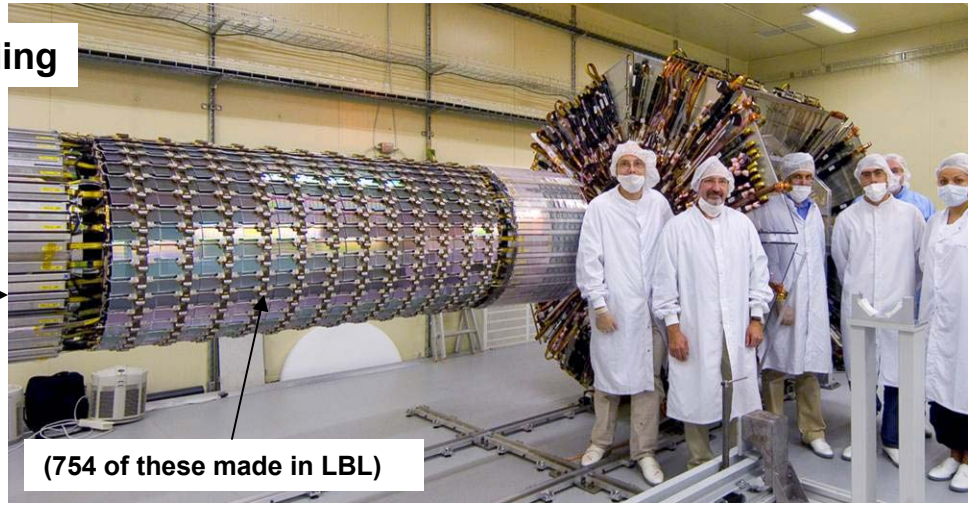
Cosmic ray in tile calorimeter



**In surface Building**

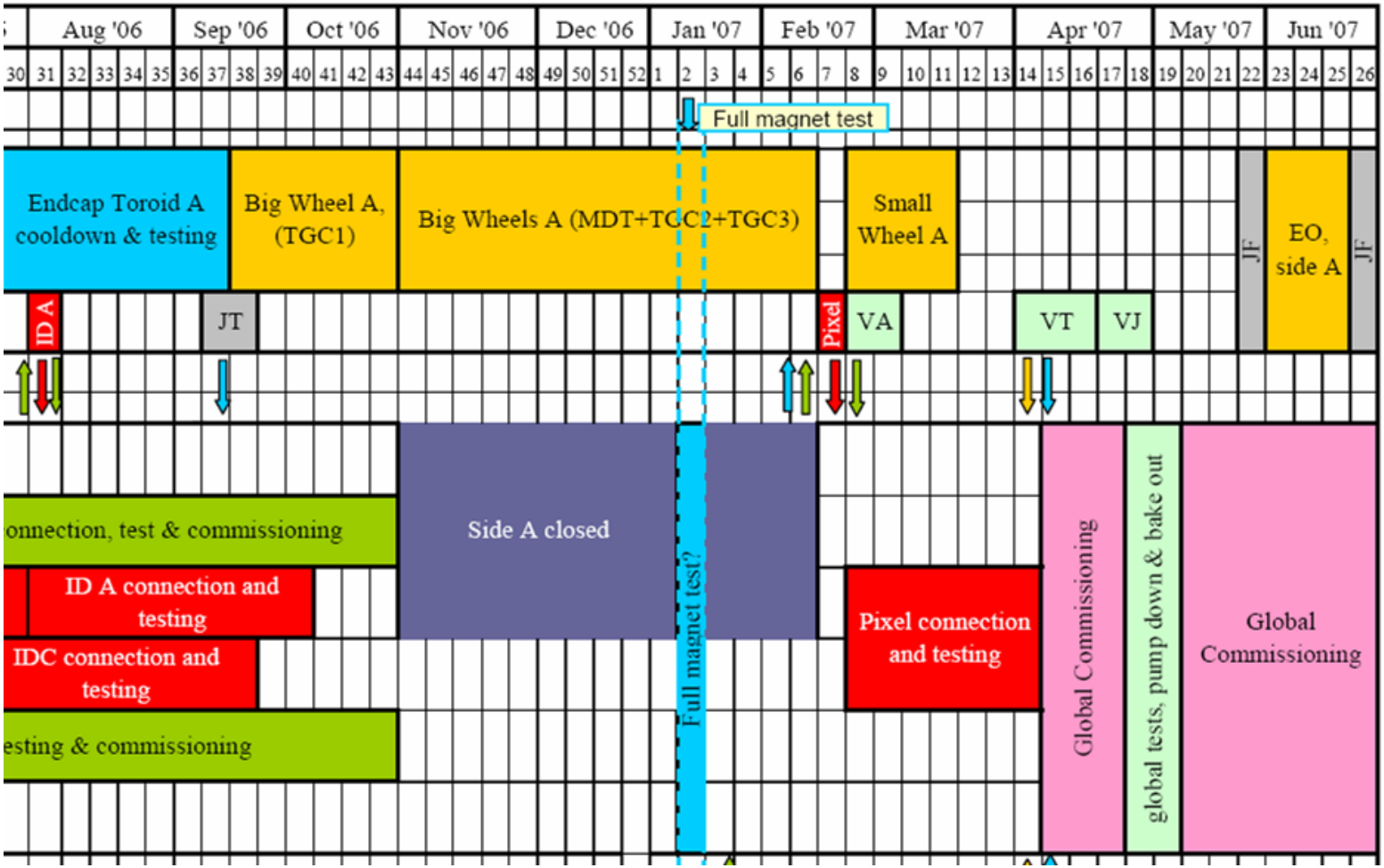
TRT wheels

SCT barrel



**(754 of these made in LBL)**

# Latest Schedule (detail)




(From M. Nessi Oct.05 overview week talk)

# Installation

## Overall ATLAS schedule (3)

- ✓ There is still room for strategical optimizations
- ✓ Possible questions:

  -> Should we delay further ECT installations and tests, in favor of a simpler access to the inside of the detector, while constructing the muon wheels ?

  -> Can we push the ID barrel 2 months in advance, by downscoping the goals of the Solenoid mapping ?

  -> ID services installation is probably the most critical item in the schedule. Should we allow more time and delay all activities accordingly ?

- ✓ *From now on we have no more contingency in the schedule and we will have to face eventual new delays and execution problems. My proposal is to keep the present schedule as a guideline and re-adapt it every ATLAS week*

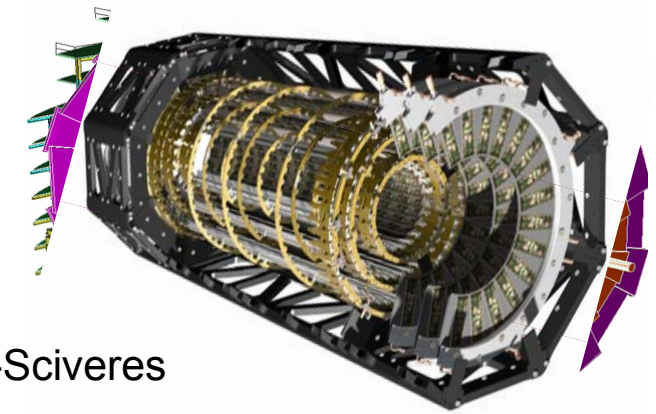
04/10/2004 Marzio Nessi, Paris 2005 67

# LBNL ATLAS Group

- Physics Division
  - J. Alonso, J-F. Arguin, M. Barnett, S. Binet, R. Cahn, *S. Cheeseboro*, A. Ciocio, *S. Dardin*, M. Dobbs*, R. Ely, K. Einsweiler, A. Gaponenko, M. Garcia-Sciveres, M. Gilchriese, T. Golling, F. Goozen, C. Haber, I. Hinchliffe, R. Jacobsen, A. Korn, S. Loken, J. Lys, R. Madaras, M. Shapiro, J. Siegrist, G. Stavropoulos, G. Trilling, S. Vahsen, *T. Weber, R. Witharm,* W. Yao
- Engineering Division
  - E. Anderssen, M. Cepeda, N. Hartman, J. Hellmers, T. Johnson, J. Joseph, R. Post, A. Smith, C. Tran, C. Vu, C. Weldon, J. Wirth
- NERSC
  - P. Calafiura, W. Lavrijsen, C. Leggett, D. Quarrie, M. Woudstra
- Grad Students
  - M. Leyton, M. Scherzer, J. Virzi, S. Zenz
- Visitors and Undergrads
  - J. Allen*, E. Feng*, D. Halberg*, J. Haller*, S-K. Ji, T. Katainen*, E. Loi, J. Rissanen*, P. Sicho*, A. Turunen*, D. Wue, E. Wulf, F. Zetti

*Departed  Resident at CERN  Retirees  *Technical/Admin*

# Hardware Activities



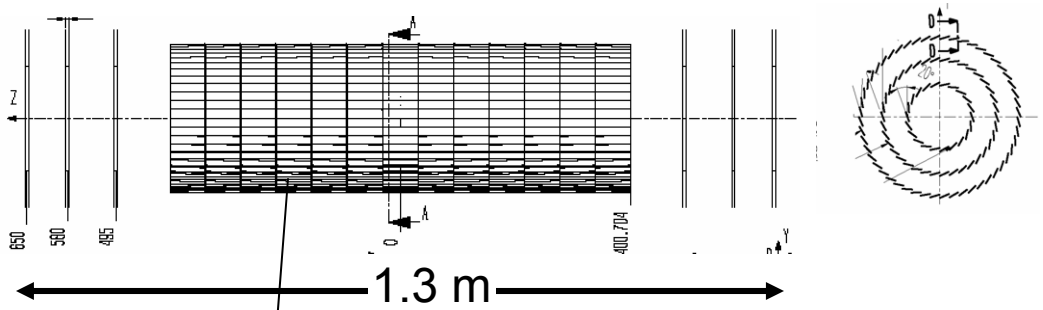
- (See next talk for Physics and Computing)
- Main involvement is in pixel detector
  - Hardware leadership roles
    - ATLAS Pixel project leader: K. Einsweiler
    - Pixel module production coordinator: M. Garcia-Sciveres
    - US Pixel responsibility: M. Gilchriese
  - Critical mechanics and services
  - Full endcaps
  - Readout integrated circuit (FE-chip), DAQ boards
  - Pixel software (covered in next talk)
- Silicon strip detector module construction ended in FY04
  - Involvement in silicon strip work continues with installation:
  - A. Ciocio managing ongoing SCT cable installation in cavern
- Upgrade work (for SuperLHC)

# The ATLAS Pixel Detector

50μm

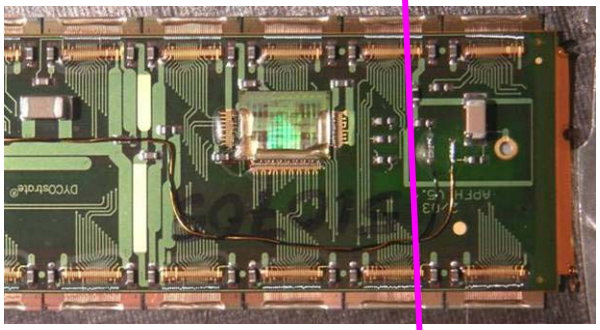
- **Will be the first and largest Hybrid Pixel Detector of its generation**
- **80M channels  at 40MHz "frame rate" rad. Hard to $10^{15}$ particles/cm$^2$**
- **Major technological achievement >10 years in the making**

**Detector Layout**

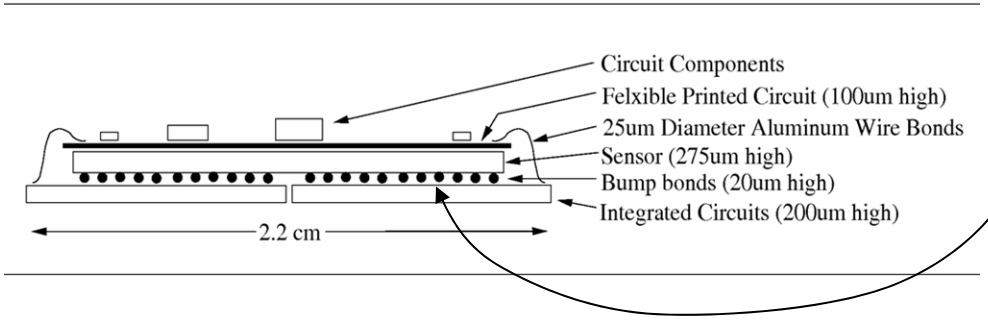



**2m$^2$ silicon active area in 1744 identical modules operated in parallel**

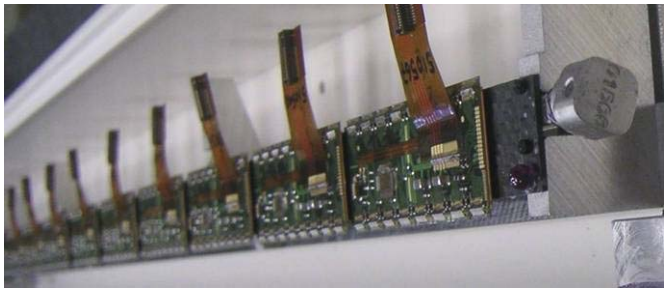
**MODULE**



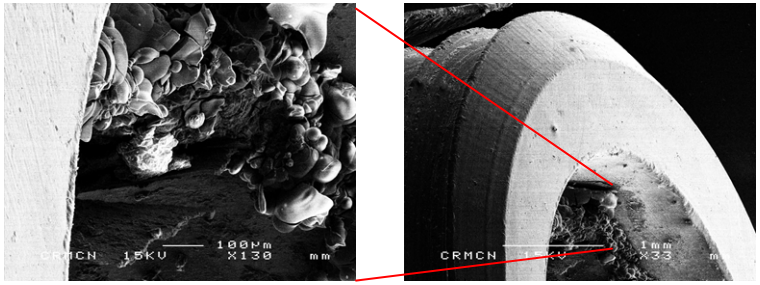
X-section through here



# Stave Pipe Corrosion Failure & Recovery



- Pixel barrel modules are held in-line on “staves”
- A stave has an aluminum cooling pipe passing under all modules.
- (Stave design and manufacture were done in Europe)
- The pipe fittings were attached by nickel-plating and brazing.
- This turned out to be a bad idea.
- Disk fittings were attached by laser welding, which turned out to be a better idea. Disks (done at LBNL) do not have a problem




corrosion

hole

## Repair Program

- 43 staves out of 112 total needed had modules loaded before problem was found.

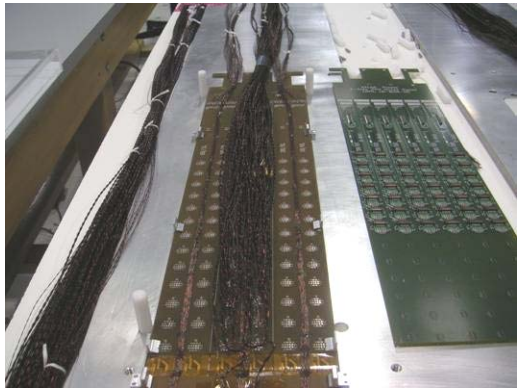
1. **These will be repaired by inserting a new tube into the corroded tube**
2. **Staves not yet loaded are being cut apart and re-assembled with a new tube**
3. **~30 Completely new staves are being manufactured**

- Pixel installation has been pushed back 4 months in ATLAS schedule (2 months came “for free” due to inner detector cable installation)
- LBNL helping with laser welding of fittings, preparation of parts for new staves, tests, reviews, etc.

# Pixel Mechanics and Services at LBNL

**Global frame, support tube, insertion test:**

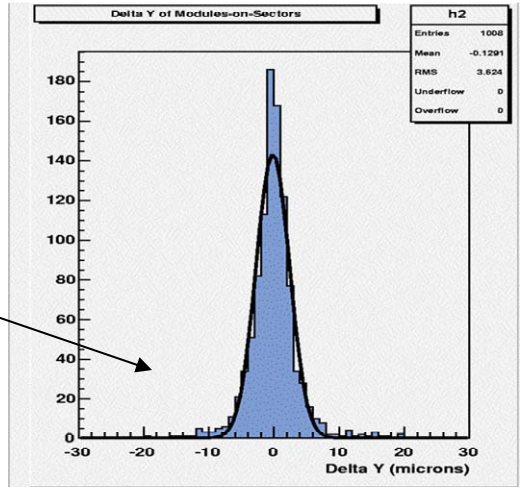

**Full services inside support tube:**



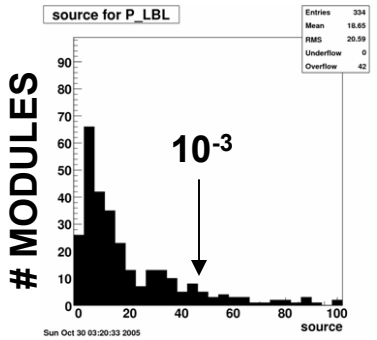
- ~100 Km of wire inside this tube
- ~180,000 solder joints
- Bundling into harnesses and component loading at vendors
- Assembly & testing in Bldg. 77A (including 25,000 solder joints)

# Pixel Endcaps at LBNL

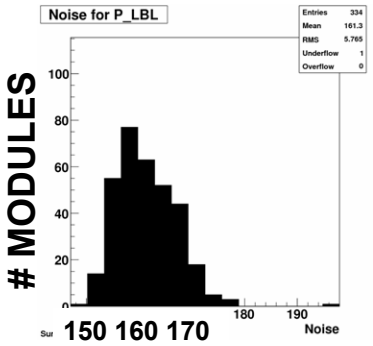
**1 of 6, 2.2Mpix**



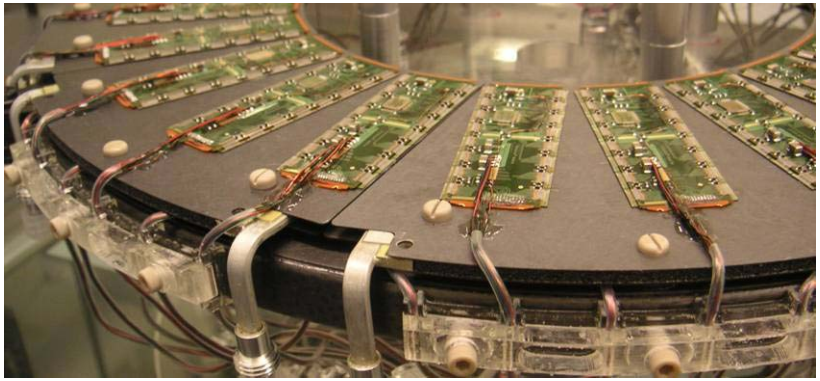

**2.6μm placement accuracy in XY**



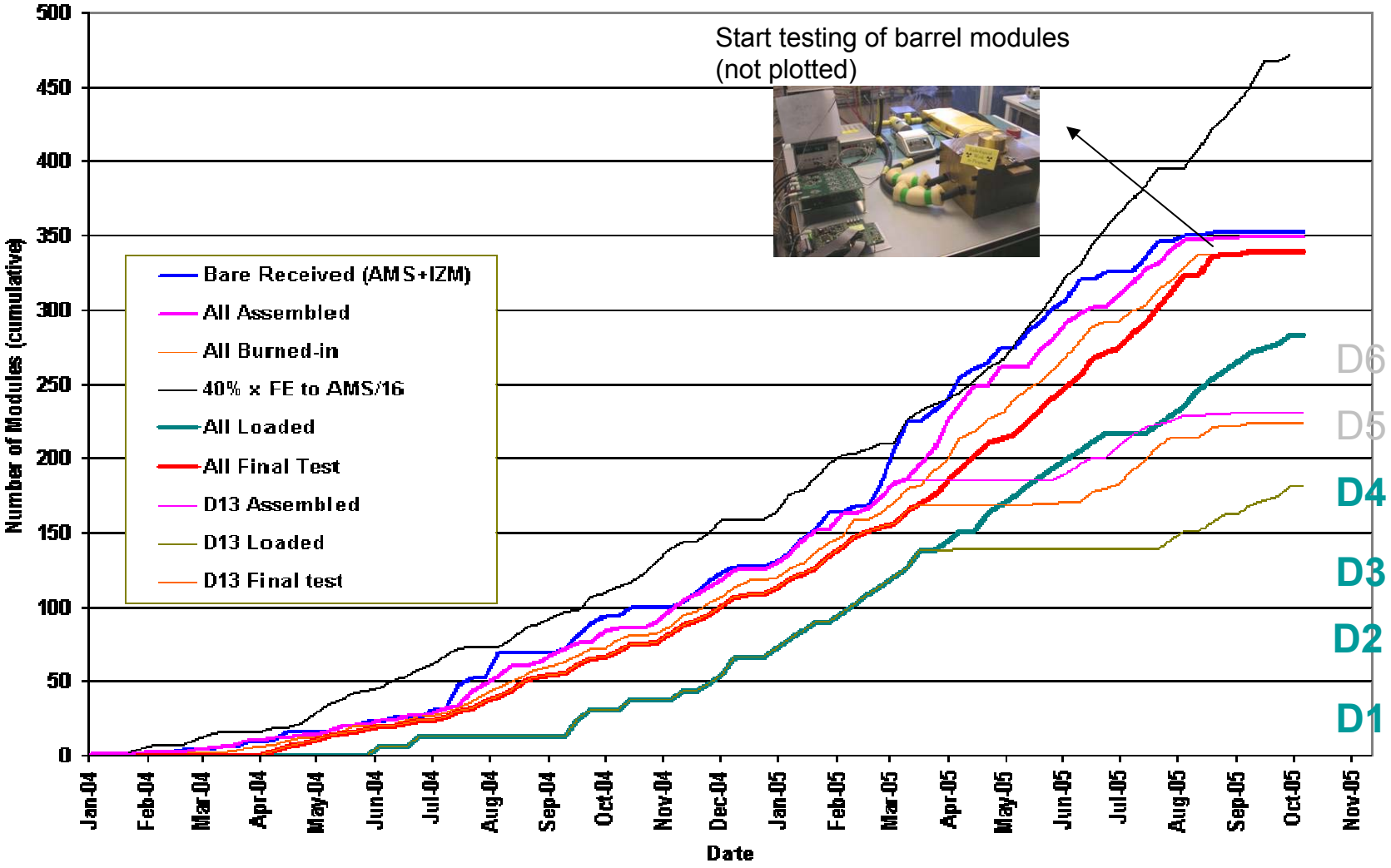

**DEAD PIXELS**




**PIXEL NOISE (e-)**



# Pixel Endcap Production



# LBNL Pixel work at CERN

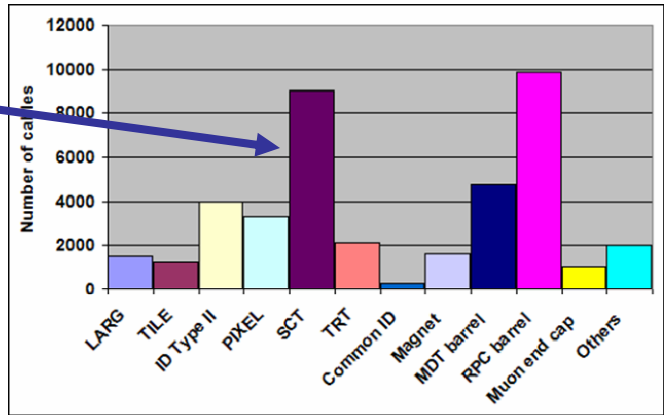
- Integration with rest of ID (Hartman) (support tube is at CERN)
- Stave repair activities (Hartman, Einsweiler)
- Integration of DAQ boards (Korn)
- System test and 10% test preparation (Korn, Einsweiler)

- Other activities have required presence of an LBNL team for weeks at a time
  - Evaporative system cooling tests
  - Dry fit or complete frame
- Integration work ramping up fast. Installation soon. As work ends at LBNL more people will move to CERN

# FY06 Pixel Hardware Plans

- Deliver to CERN complete C-side End Section in March
- A-side end-section soon after
- Deliver complete “type 1” services by the Summer.
- END OF PIXEL CONSTRUCTION WORK AT LBNL
- 10% test at CERN, leading up to full detector commissioning
- Help with stave repair and barrel production in order to meet tight installation schedule

# SCT cable installation




- It has been necessary to draft collaboration members for shift to plug in and test cables.
- This activity is being managed by A. Ciocio

- Installation of first half of the SCT Type 4 cables required 166 shifts manned by physics personnel from 17 SCT institutions

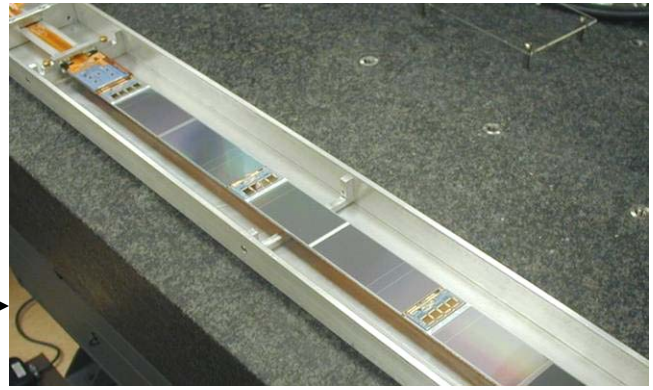
SCT Type 4 cables in rack

- A preview of things to come for pixels

# SLHC Upgrade

- Why are we worrying about the UPGRADE to the still unfinished ATLAS?!
- The LHC will REQUIRE a major upgrade after 700fb-1 due to radiation damage to machine elements.
- This will happen around 2015
- Detector R&D for the present phase of the LHC was already a major activity in the early 1990's: >15 years before LHC turn-on
- First full size prototype pixel readout chip was fabricated in 1997
- The SuperLHC will aim at increasing luminosity x10
- The present Inner detector must be entirely replaced for this
  - R<20 cm (presently pixels): unprecedented dose. No proven technology yet.
  - 20<R<50 cm: large area "pixel-like" layers to replace strips (SCT)
  - R>50 cm: large area strip system to replace straw tubes (TRT)
- The SLHC detector upgrade effort is by now well established within global ATLAS

# Upgrade activities



- 4 main R&D areas at LBNL:
  1. Basic unit for a large strip detector (TRT replacement). Also called “stave”. Based on CDF Run 2b development. Collaboration with RAL, BNL, UCSC, Allcomp
  2. How to operate a large detector at -30C. Mechanical support and cooling (with Allcomp)
  3. R<20 active elements (electronics and testing of detectors) that can survive the $10^{16}cm^{-2}$ fluence. **STALLED (see below)**
  4. How to avoid the cable nightmare we are faced with now by better power distribution.
     - Serial power approach will be tested on prototype stave in collaboration with RAL
     - DC-DC converter R&D- **DELAYED**
- The ATLAS pixel chip is the most complex chip yet to come out of the LBNL IC group
- The entire design team has since left the lab!
- New hires at similar skill level have NOT been made
- While similar crises have happened before, as project complexity and longevity increase, a “revolving door” IC group can no longer deliver.
- There is a real risk that there will NOT be a next generation pixel chip
- A better model with more laboratory support is needed if this core competency is to be maintained.

# Conclusion

- LHC and ATLAS are very much on track for 2007 collisions
- LBNL has played a major role in both the development and the on-going construction of the pixel detector
- Installation is around the corner and it will not be acceptable to ship our deliverables and watch from here. As a leading institution in the pixel project we must put all hands on deck to make it a success.
- Many innovations in the present detector were a result of LBNL core competencies. However, our rich IC design tradition may not survive without help from the laboratory.
- Stick around for PART 2!